REMARKS

Reconsideration is respectfully requested in view of the following remarks.

The Invention

The present invention is directed to an electrochemical cell having an open ended cylindrical housing and an end cap assembly inserted therein closing said housing. The end cap assembly has a metal support disk and an underlying electrically insulating sealing disk abutting a side of the metal support facing the cell interior. The metal support disk has a downwardly extended surface, which extends downwardly from a high point thereon to low point thereto. The downwardly extended surface is preferably slanted at an angle of between 40 and 80 degrees from the cell's central longitudinal axis so that the high point is closer to the cell's central longitudinal axis than said low point when the cell is viewed in vertical position with the end cap assembly on top. The downwardly extended surface of the metal support has at least one aperture therethrough and the insulating sealing disk has a downwardly extending wall abutting such aperture in the metal support. The wall of the insulating sealing disk abutting said aperture has a groove on its inside surface facing the cell interior.

The seal rupture process begins at the groove site and the groove assists in achieving a uniform rupture in tension of the portion of said insulating seal abutting said aperture, when gas pressure within the cell rises to a predetermined level. The groove on the inside surface of the sealing wall also facilitates the molding process by allowing the region in said sealing wall immediately surrounding the groove to be thicker to enable improved mold flow.

The combination of features of the invention result in a significant improvement in cell design and operation. The

pronounced slant of the metal support member allows for insertion therein of a larger size aperture. This in turn means that for a given thickness of insulating seal underlying and abutting said aperture, the threshold rupture pressure of said underlying seal can be reduced. The advantage of being able to design the cell to vent (by membrane rupture) at lower thresholds of gas pressure buildup in turn leads to an end cap assembly requiring less head room and therefore leaves more space available for anode and cathode material. The lower rupture pressure means that the cell housing wall thickness may be reduced. Thus, for steel housings a benefit of the invention is that the housing wall thickness may be reduced to a level of between about 4 and 8 mils (0.10 and 0.20 mm). (Conventional housing wall thickness of cylindrical cells are normally higher, for example, about 10 mil. See reference thereto in Applicant's specification at p. 14, line 8.)

Another way to reduce the threshold rupture pressure of the seal portion (membrane seal) underlying said aperture in the metal support would be to continue to reduce the seal wall thickness in that area. (The rupture pressure, i.e. rupture point, of a membrane in Applicant's configuration varies approximately directly with its thickness and inversely with the rupture radius.) However, to achieve very low rupture pressures, for example, to a level between about 500 to 700 psig (3.38×10^6 and 4.83×10^6 pascal) for alkaline AA cells and 300 to 400 psig (2.03×10^6 and 2.70×10^6 pascal) for alkaline C and D cells the rupturable portion of the seal would have to be too thin for it to be achieved with state of the art molding technology without the use of a slanted metal support member. The pronounced slant on the downwardly extending surface of the metal support member allows for larger area for seal rupture, which in turn means that for a given thickness of rupturable seal wall (underlying the aperture in the metal support), the threshold rupture pressure will be less.

The underlying groove on the seal wall allows for a thicker seal wall in the region immediately surrounding the groove. This allows for good moldability of the seal wall during manufacture. The groove also assists the rupture process, so that the rupture process begins at the groove site and results in a uniform rupture of the insulating seal wall. Just before rupture the seal wall underlying said aperture expands in tension. The groove on the surface of the rupturable seal wall reduces the amount of expansion required before rupture, reducing the amount of head room needed above the seal. This in turn means there is more space available in the cell interior for anode and cathode material.

Thus, the pronounced slant of the metal support surface with aperture therein and underlying grooved, rupturable seal abutting said aperture, leads to an improved cell design having more interior space available for anode and cathode material and also allows for a reduction in the cell housing wall thickness.

The Rejections

Claims 1-19, and 22-23 have been rejected under 35 USC 103(a) as being unpatentable over Sargeant (U.S. 6,127,062) in view of Bowsky (U.S. 4,803,136).

Claims 20 and 21 have been rejected under 35 USC 103(a) as unpatentable over Sargeant (U.S. 6,127,062) in view of Bowsky (U.S. 4,803,136) as applied to claim 8 above and further in view of Urry (U.S. 6,333,127).

Discussion of the References

Sargeant (U.S. 6,127,062) discloses an electrochemical cell, for example an alkaline cell, comprising an end cap seal assembly inserted into the open end of a cylindrical housing for the cell. In one aspect the end cap assembly comprises an end

cap disk and an insulating disk member (insulating grommet) underlying the end cap disk. The insulating disk electrically insulates the terminal end cap from the cell housing. The end cap is formed of a single piece metallic construction having a convoluted surface. The end cap may be exposed and may function as a cell terminal. The end cap has a downwardly extending wall which extends downwardly from a high point on the surface of the end cap and towards a lower point on said surface which is closer to the cell interior. The insulating disk has a convoluted surface. It has a thick region near the center forming a boss and also has a downwardly extending wall which extends downwardly from a high point on the surface of the insulating disk and towards a lower point on said surface which is closer to the cell interior. The downwardly extending wall of the insulating disk underlies and preferably abuts and contacts a portion of the inside surface of the downwardly extending wall of said terminal end cap.

Sargeant discloses that the downwardly extending wall of said end cap has at least one aperture therethrough and a portion of the downwardly extending wall of the insulating disk forms a rupturable membrane which abuts the aperture in the end cap disk. Preferably the rupturable membrane contacts a portion of the inside surface of the end cap disk immediately adjacent the aperture. The aperture and underlying rupturable membrane may be visible from the cell exterior. When gas pressure within the cell reaches a predetermined level the rupturable membrane underlying the aperture extrudes through the aperture and ruptures thereby releasing gas directly into the surrounding environment through said aperture. Sargeant teaches that it is preferable to locate the rupturable membrane on a downwardly extending wall of the insulating disk.

In Sargeant's first embodiment (Figs. 1-3) the end cap functions as a metal support. In another embodiment (Fig.4) he discloses a separate end cap 120 overlying metal support 40 with

downwardly sloping wall 45 with aperture 48 therethrough and an insulating seal side wall 26 abutting said aperture. Insulating seal wall 26 ruptures through aperture when gas pressure within the cell rises to a predetermined level. As may be seen from his drawings, Sargeant's downwardly extending metal side wall 45 is nearly or substantially vertical. However, Sargeant indicates in the specification that the metal side wall 45 may be of other angle, preferably from 0 to 45 degrees from vertical. (col. 5, lines 19-24.)

Nevertheless, Sargeant does not teach that a greatly slanted metal side wall 45 at angle of between 40 and 80 degrees from vertical in conjunction with a grooved undercut on the inside surface of his insulating seal side wall 26 abutting aperture 48, would result in any particular benefit. In fact Sargeant does not disclose the use of such grooved undercut in connection with any of the embodiments of his invention as described his specification. By contrast applicant's invention is directed to such combination, namely a metal side wall of pronounced slant (40 to 80 degrees from vertical) with aperture therein together with an abutting insulating seal side wall having a groove on its inside surface facing the cell interior. As described in the above Summary of Applicant's invention such combination allows for larger diameter apertures in the downwardly extending metal support side wall and allows for reduced threshold rupture pressures in turn leading to reduction in the cell housing wall thickness. Such combination resulting in such overall benefit is not taught in Sargeant.

For example, as stated in Sargeant, in an AA cell for his principal embodiment (Figs. 1 and 2) the design rupture pressure would be at 1000 psig. For the D size cell the rupture pressure would be at 500 psig. (Col. 6, lines 22-32). By contrast in Applicant's end cap assembly design the rupture pressure can be reduced to much lower levels. For example as stated in Applicant's specification, rupture of membrane 23 abutting

aperture 48 within metal support side wall 45 can be at lower pressure, of about 500 to 700 psig (3.38×10^6 and 4.83×10^6 pascal) for alkaline AA cells and 300 to 400 psig (2.03×10^6 and 2.70×10^6 pascal) for alkaline C and D cells. This leads to a reduction in housing wall thickness desirably between 0.004 and 0.008 inches (0.10 and 0.20 mm) preferably between about 0.006 and 0.008 inches (0.15 and 0.20 mm). (See, Applicant's specification at p. 13, last para. to page 14, line 18 and p. 20, lines 20-22.)

In sum it would not be apparent from Sargeant's disclosure that reduction of the rupture pressure and housing wall thickness can be so much reduced by Applicant's <u>downwardly extended slanted metal support surface</u>, at angle between about 40 and 80 degree from vertical in <u>combination</u> with a <u>grooved seal abutting an aperture</u> in said metal support slanted surface.

Bowsky (U.S. 4,803,136) discloses a method of etching the <u>metal container</u> of an electrochemical cell in order to form etched arcs 7 forming rupturable thinned (grooved) regions on the metal container surface. The reference also discusses prior art involving other methods of forming such grooved vents in the metal surface such as by stamping, pressing or coining, to form a weakened (grooved) area, which may include an intermediate annealing step. But Bowsky points out that such methods have disadvantages since there is a change caused in the residual stresses in the metal in turn causing an increase of susceptibility to stress corrosion. In addition the metal itself hardens and becomes brittle, resulting in uncontrollable metal fracture. (col. 2, line 65 to col. 3, line 4)

Bowsky also alludes to a paper by Baylis C. Navel presented at the Third International Seminar on Lithium Battery Technology and Applications (1987) entitled "Rupture Disk Development and Application". Bowsky references this paper at p. 4 under the heading "Cell Vents" that venting by .... reforming, stamping,

scoring, machining, gouging, and chemical milling ... were considered to be inferior and unacceptable. Such discussion of the prior art can hardly be said to encourage the use of grooved vents made by such methods.

In any event Bowsky etching process is applied to produce an etched thinned region in the form of etched arcs in a metal surface, namely, a metal container for an electrochemical cell. By contrast Applicant's grooved portion is applied to the underside of an insulating sealing member, which is plastic, not metal. For clarity Applicant has amended the independent claims 1, 8, and 25 to recite that the insulating sealing disk comprises plastic material so that it will be appreciated that such grooved undercut region is of plastic material. Thus, Bowsky should not be considered squarely relevant with respect to Applicant's downwardly extending insulating seal wall 26 having an undercut grooved portion 210.

In sum Bowsky clearly does not disclose Applicant's grooved vent 210 on the underside of plastic insulating wall 26 abutting aperture 48 in downwardly extending wall 45 of metal support disk 40. Bowsky is concerned with forming an etched vent portion on a metal container surface, not a plastic insulating seal.

Urry (U.S. 6,333,127) is directed to a process of assembling an electrochemical cell wherein the electrochemically active flakes, in particular zinc flakes, are coated with gelling agent and then are vibrated within the cell container so that they become oriented substantially perpendicular to the separator side walls. Urry also discloses an electrochemical cell embodiment with an end cap assembly for closing the cylindrical housing open end. In Urry's end cap assembly the elongated anode current collector can be welded to the terminal end cap. (col. 3, lines 30-40). Applicant acknowledges that such

welded feature, per se, as recited in Applicant's claims 20 and 21, is within in the prior art.

Arguments Against the Rejections Under 35 USC 103

Independent claim 1 and 8 have been rejected under 35 USC 103(a) as being unpatentable over Sargeant (U.S. 6,127,062) in view of Bowsky (U.S. 4,803,136).

Sargeant (U.S. 6,127,062) discloses a downwardly extending surface of a metal support disk 40 having an aperture 48 therein and a downwardly extending wall 26 of a plastic insulating seal membrane 23 abutting said aperture. Sargeant discloses that the degree of slant of the downwardly extending surface of the metal support may be between 0 and 45 degrees from vertical. (col. 5, lines 19-24) As the Examiner points out Sargeant also discloses that the aperture may be from 3 mm^2 and 50 mm^2 (col. 6, lines 10-15). Admittedly this overlaps Applicant's claimed range of 40 to 80 degrees from vertical. Sargeant states in broad terms that membrane 23 thickness and aperture 48 size may be adjusted depending on the material employed and the level of rupture pressure intended. (col. 6, lines 48-51)

However, Sargeant does not contemplate adding a <u>grooved undercut</u> to the portion of insulating seal abutting said aperture in the metal support disk. There is no disclosure or suggestion in Sargeant that such undercut would be of any particular benefit or for that matter would even be feasible. Furthermore Sargeant does not teach or contemplate that increasing the slant of the downwardly extending surface of the metal support disk to within Applicant's range of 40 to 80 degrees from vertical can lead to a reduction in the cell housing wall thickness, namely to a level of between about <u>4 and 8 mils</u>. This is an unobvious benefit of Applicant's end cap assembly design.

Bowsky (U.S. 4,803,136) discloses etched arcs on the surface of a metal container for electrochemical cells. The etched arcs forms weakened or rupturable grooved sites on the surface of the metal container so that as when gas pressure within the container exceeds a predetermined level the container will rupture at the etched site. Bowsky does not show Applicant's claimed combination of a downwardly extending surface of metal support disk having an aperture therethrough with a downwardly extending wall of a plastic insulating seal abutting said aperture. Furthermore, although Bowsky references prior art generally that show rupturable grooved vents formed by cutting, scoring and the like, such cited art appears to be directed to metal containers, not to plastic members. In any event, there is no teaching in Bowsky to suggest any benefit in forming undercut grooves to a plastic insulating seal wall abutting an aperture in a metal support disk.

Independent claims 1 and 8 as amended now recites a downwardly extending surface of a metal support disk at a slant of between 40 and 80 degrees from vertical and having an aperture therein and a wall of a plastic insulating seal abutting said aperture in combination with a groove on the side of the insulating wall facing the cell interior. Sargeant does not disclose or suggest such groove cut on any portion of the insulating seal wall abutting said aperture. Bowsky deals with forming rupturable grooves on surface of metal containers not plastic seal members. In particular there is nothing in Bowsky to indicate the desirability of applying an undercut groove to a plastic seal wall which abuts an aperture in a downwardly extending metal support member, which is Applicant's claimed combination.

Accordingly, independent claims 1 and 8 as now amended are believed to be patentable over the combination of references Sargeant and Bowsky. Withdrawal of the rejection of claims 1 and

8 under 35 USC 103 is respectfully requested upon the Examiner's reconsideration.

Independent claim 25 as amended, now recites a downwardly extending surface of a metal support disk having an aperture therein and a wall of a plastic insulating disk abutting said aperture, wherein said wall of the insulating seal is at a slant of between 40 and 80 degrees from the cell's central longitudinal axis, in <u>combination</u> with a groove on the inside surface of said abutting insulating wall forming a rupturable membrane. In addition claim 25 as amended, also includes the limitation that the cell housing wall has a thickness of between 4 and 8 mils (0.10 and 0.20 mm).

As above stated Sargeant does not disclose or suggest such cut groove on any portion of the insulating seal wall abutting said aperture. Bowsky deals with forming rupturable grooves on surface of metal containers not plastic seal members. In particular there is nothing in Bowsky to indicate the desirability of applying an undercut groove to a plastic seal wall abutting an aperture in a downwardly extending metal support member, which is Applicant's claimed combination. Additionally, neither of these references discloses such plastic insulating seal wall abutting an aperture in a metal support member, wherein the cell housing wall thicknesses is within Applicant's stated low range of between 4 and 8 mil.

Accordingly, independent claim 25 as now amended is believed to be patentable over the combination of references Sargeant and Bowsky. Withdrawal of the rejection of claim 25 under 35 USC 103 is respectfully requested upon the Examiner's reconsideration.

Dependent claims 20 and 21 have been rejected under 35 USC 103(a) as unpatentable over Sargeant (U.S. 6,127,062) in view of Bowsky (U.S. 4,803,136) as applied to claim 8 above and further

in view of Urry (U.S. 6,333,127). Claim 20 recites that the elongated current collector is welded to the metal support disk. Claim 21 directed to welding the current collector to the end cap has been canceled.

Claims 20 includes the limitation that the elongated current collector is welded to the metal support disk, but depends directly from independent claim 8. Claim 20 reflects a specific embodiment further limiting claim 8. The added reference Urry does not show the combination of features Applicant recites in amended claim 8. But Urry does disclose welding of an elongated current collector to a terminal end cap, which in the embodiment shown can be said to function as a metal support member. Applicant's Claim 20 should be patentable if claim 8 is allowed, since it further limits the scope of main claim 8 and reflects a specific embodiment of the invention. Withdrawal of the rejection of claim 20 under 35 USC 103 is requested upon reconsideration.

Patentability of claims 3 and 12 is specifically argued in that none of the cited references suggests a reduction of the cell housing wall to a thickness of between 4 and 8 mil (0.10 and 0.20 mm) is made possible by having Applicant's combination of features, namely, a grooved insulating seal abutting an aperture in a downwardly slanted metal support wall as recited in base claims 1 and 8. Allowance upon reconsideration of claim 3 dependent on base claim 1 and claim 12 dependent on base claim 8 is requested.

Dependent claims 4-6, 9-11, 17, 26-29, and 34-35 recite preferred physical features of the groove underlying the downwardly extending insulating seal wall abutting said aperture in the metal support disk. The recited features in these claims include features such as groove width, groove configuration and preferred thickness for the membrane underlying the groove. They reflect preferred embodiments of the invention further limiting

the base claims. Thus, these claims should be allowable if the base claims 1, 8, and 25 are allowed. Allowance of these claims upon reconsideration is requested.

Claim 17 dependent on base claim 8 and claim 29 dependent on base claim 25 recite the aperture in the downwardly extending surface of the metal support disk as having an area of between 7 and 16 mm^2. Claims 17 and 29 further recites that such aperture area is in combination with the rupturable membrane and groove in the seal wall abutting the aperture, wherein the membrane thickness at the base of the groove is between 0.08 and 0.15 mm. Applicant argues patentability of these claims specifically, since none of the cited references suggests such combination of features. Withdrawal of the rejection of dependent claims 17 and 29 upon reconsideration is respectfully requested.

Applicant has made every effort to place the application in condition for allowance. A favorable Action and Allowance is solicited upon the Examiner's reconsideration.

The undersigned attorney solicits a telephone call from the Examiner to clarify any questions which the Examiner may have concerning the application. Authorization is hereby given to debit Deposit Account 502271 for any amount owing or credit the same account for any overcharges in connection with this communication.

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Respectfully submitted,

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I certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on May 4, 2004.

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